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USE OF BLOCKCHAIN/WEB.3 (METAVERSE) TECHNOLOGY AT EU LEVEL: ESTIMATION OF THE INNOVATIVE LEVEL OF THE MOLDOVAN ECONOMY WITH A VIEW TO ASSIMILATING THESE TECHNOLOGIES

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Abstract: *In 2016, the World Economic Forum recognized blockchain technology as one of the ten most important emerging technologies. Prior to this recognition, The Economist published articles about the "trust machine," introducing this remarkable technology to a wider audience. In order to understand the progress of blockchain technology and its current state, it is essential for countries to research these issues in relation to their economies. It is important to distinguish between theoretical blockchain applications and their commercial applications to assess the potential disruption of existing business models by blockchain technology. This article presents the European initiative in applying this technology and estimates the Moldovan economy's preparedness in this regard. To achieve this, we have set the following objectives: describing the principles and directions of the EU Blockchain/Web3 Strategy; conducting a comparative analysis of the level of innovation in the Moldovan economy with two EU member states; estimating the potential for future use of these technologies, and outlining the necessary skills and abilities. This research is relevant because it identifies the actions that the Moldovan economy must take to achieve a level of innovation and economic progress on par with the EU.*

Keywords*: blockchain, Web3, metaverse, EU Blockchain Web3 Strategy, digital skills.*

JEL Code: *O30, O32*

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Introduction

Blockchain/Web3 technology allows individuals and organizations to trust each other without the intervention of a third party. By creating trust in data, blockchain has the potential to revolutionize the way we share information and conduct transactions online. The extraordinary innovation introduced by blockchain technology is that the network is open, and participants do not need to know each other to interact.

Electronic transactions can be verified and recorded automatically by network nodes using cryptographic algorithms, without human intervention, central authority, checkpoint, or third party: e.g., governments, banks, financial institutions, or other organizations (Pisaniuc, 2023).

Even if some nodes are insecure, dishonest, or malicious, the network is able to correct, verify transactions correctly, and protect the ledger from tampering through a mathematical proof-of-work system.

Web3. The metaverse would thus become the future general container for digital technologies. This position has become highly controversial. Particular emphasis has been placed on the commercial side of the metaverse and the search for new sources of profit for digital businesses (Floridi, 2022).

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However, recent developments show that additional profits are difficult to materialize. Zuckerberg's companies suffered considerable stock market losses in 2022. Meta Platforms is the largest social media company in the world. Meta, with its large user base, has gained a prominent role in the advertising space. But it faces stiff competition: not only from players such as Google, Amazon, and Twitter, but also Apple, YouTube, and Tencent.

Interest in the idea of the metaverse exploded in 2021-2022, triggered by Facebook's decision to change its name to "Meta". The word was coined by science fiction writer Neal Stephenson in 1992 in his novel Snow Crash.

In today's terms, the Metaverse is the domain of computer-generated and networked extended reality, or XR (Expanded Reality), an acronym that encompasses all aspects of augmented reality, mixed reality, and virtual reality (AR, MR, and VR). Currently, the Metaverse generally consists of somewhat immersive XR spaces where interactions between people and automated entities take place.

Some are everyday interactions with augmented reality applications that people have on their computers and phones. Others are interactions that take place in more immersive environments in games or fantasy worlds.

Some take place in "mirror worlds" that replicate real-life environments. The MV can be viewed as a network of virtual phytogital worlds/spaces on a horse platform.

Virtual representations of a person's identity are adopted in this simulated environment: Avatars, which can be seen as the embodiment of MV users The development of MV is closely linked to the evolution of the web, Mark Zuckerberg (2022) defined the Metaverse (MV) as "the embodiment of the Internet".

The Metaverse may represent the next iteration of the internet (Web 3.0), in which "the boundaries between our physical and digital lives are increasingly blurred", so that "the great debate on cryptography may be just a starting point on the journey to the Metaverse".

Based on global and European trends in this field, we wanted to assess the country's level of preparedness for alignment with European requirements and the implementation of these technologies in the economy. To this end, we wanted to discuss two key questions:

- Q1, What is the level of innovation in the Moldovan economy from the perspective of EU integration?
- Q2, What is the future potential for absorbing this technology, reflected in quantitative and qualitative indicators?

Literature Review

The field of research in question, that of disruptive technologies, is a new one for both foreign and domestic researchers. However, published works on blockchain technology tend to focus on describing these technologies and their areas of application, (Pilington; Crudu, 2017), (Secrieru et. all, 2024), or on studies related to products associated with blockchain technology, namely cryptocurrency. The blockchain contains a certain and verifiable record of every single transaction ever made. To use a basic analogy, it is easier to steal a cookie from a

cookie jar, kept in a secluded place, than stealing the cookie from a cookie jar kept in a market place, being observed by thousands of people (Crosby et. all, 2016).

In the opinion of many experts and specialists, some of whom are quoted in the article, this technology is synonymous with bitcoin or other cryptocurrencies Diffe W. Helman M. (1976). Blockchain-based applications are springing up, covering numerous fields including financial services, reputation system and Internet of Things (IoT), and so on. However, there are still many challenges of blockchain technology such as scalability and security problems waiting to be overcome.(Zheng et all, 2017)

The focus of this study is actually on how prepared the country's economy is to assimilate these technologies of the future. It estimates the innovative potential in terms of business sophistication and the ability to produce innovations now and in the future.

As a database, we used recent international publications in the field, the Global Innovation Index Report published by WIPO, the UNECE (United Nations Economic Commission for Europe) Report, and official EU documents. The opinions of researchers, experts, and entrepreneurs relevant to this topic are also presented.

The subject addressed in this article is the presentation of our own point of view on this topic, the selection of relevant comparable indicators for the countries compared, and the information that essentially constitutes the originality and added value of the publication.

Methodology

In the research process, we used quantitative methods, reflected in the analysis of data from global reports, as well as qualitative analysis by addressing the skills required to use blockchain technologies. We also used methods such as data analysis and synthesis, deduction, and forecasting based on globally recognized indicators. Critical analysis based on factual data.

In order to validate the results, we conducted a comparative analysis with two EU member states: Romania as a neighboring country, and Latvia. Latvia was chosen because it is a small country in terms of territory and population and has the most modest results in terms of innovation compared to Lithuania or Estonia. We considered these two countries to be the most relevant for the comparative analysis at the current stage of innovation in the Republic of Moldova.

Research results

First and foremost, we wanted to present the key ideas of the EU Commission's WEB 3 Blockchain Strategy. This strategy supports the use and development of key areas of blockchain/web3 technology in line with European values and regulations.

It creates improved trust services because blockchain solutions offer a high level of trust and are used in many projects, policy actions, and investments in research and development. The sectors of application are diverse: such as climate, energy, mobility, and agriculture. In this context, the technology must be sustainable and energy efficient.

Last but not least, blockchain technology should ensure compliance with strict EU regulations on data protection and privacy.

This technology aims to improve the evolving digital identity frameworks for individuals, organizations, and objects. It can contribute to the implementation of the EUDI framework and support other relevant authentication purposes.

Blockchain technology can provide a high level of cybersecurity. Most importantly, for blockchains and Web3 to be successful, they must be interoperable with each other and with other existing systems.

Transforming industries and cross-border public services in Europe

Together with big data, artificial intelligence, and the Internet of Things, blockchain can help transform industries and public services in Europe to address the dual challenge of digital and sustainable growth. By promoting decentralization, it is particularly relevant in the context of a fair, green, and sustainable post-COVID recovery. For example, blockchain technologies can be used to facilitate the monitoring and efficiency of supply chains.

Building a citizen-centered digital society

Blockchain can help us build a fair, inclusive, secure, and democratic digital economy in Europe - for example, as the infrastructure behind a more citizen-centered, privacy-oriented, and secure internet and digital single market, by supporting e-voting and proposing new decentralized identity models.

Blockchain is a key technology for sustainability

The first generation of blockchain was energy-intensive for updating the decentralized database. However, more advanced blockchain technologies today consume no more electricity than traditional databases. Through regulations, public procurement, and policy initiatives, the European Union is promoting sustainable blockchain technologies over unsustainable ones.

As the EU promotes increased sustainability in blockchain technologies, it also supports the role that blockchains can play in a more sustainable economy to help achieve the European Green Deal. The Commission recognizes the importance of legal certainty and a clear regulatory regime in areas related to blockchain-based applications. It is currently implementing a legal framework conducive to innovation through the regulation of the crypto-assets market.

The European Commission has introduced provisions on smart contracts in the Data and Electronic Registers Act of the EU Digital Identity Regulation to protect consumers and provide legal certainty to businesses. The European Blockchain Sandbox (EBS), launched in February 2023, supports 20 innovative blockchain projects each year, encouraging cross-border regulatory dialogue and seeking to prevent legal fragmentation (European Commission, 2025).

The EBS provides a framework for cross-border regulatory dialogue between regulators, supervisors, and blockchain innovators. The 2024 Best Practices Report, published after the first regulatory dialogues, explores their results.

The EU provides funding for blockchain research and innovation through grants and support investments. The Commission has funded around 200 research and innovation projects, for innovation and piloting web3 in various fields of application. Between 2016

and 2024, research and innovation (R&I) programs under Horizon 2020 and Horizon Europe (EC) have provided grants worth approximately €700 million for projects involving blockchain or ledger technologies.

The Commission, in partnership with the European Investment Fund (EIF), has provided €100 million to set up the first European investment fund for artificial intelligence/blockchain. The fund attracts additional private investment through venture capital funds. The total investment volume in the first phase is estimated to be between €500 million and €700 million. The EU, together with its member states, plans to expand the AI/blockchain investment fund under the InvestEU program and the Recovery and Resilience Facility.

The Metaverse economy. This type of economy will also consist, perhaps primarily, of peer-to-peer sales. Let's take Roblox as an example. On the platform, users have the ability to create their own games using Roblox's development tools. They can then monetize their creations by selling them to other users.

The Metaverse refers to the convergence of physical and virtual space, accessed through computers and facilitated by immersive technologies such as virtual reality, augmented reality, and mixed reality (Ball, 2022).

Described by proponents as the next iteration of the internet, this 3D virtual world is seen as a persistent, collective, and shared space where our digital facsimiles, or avatars, move freely from one experience to another, taking our identity and monetary assets with us.

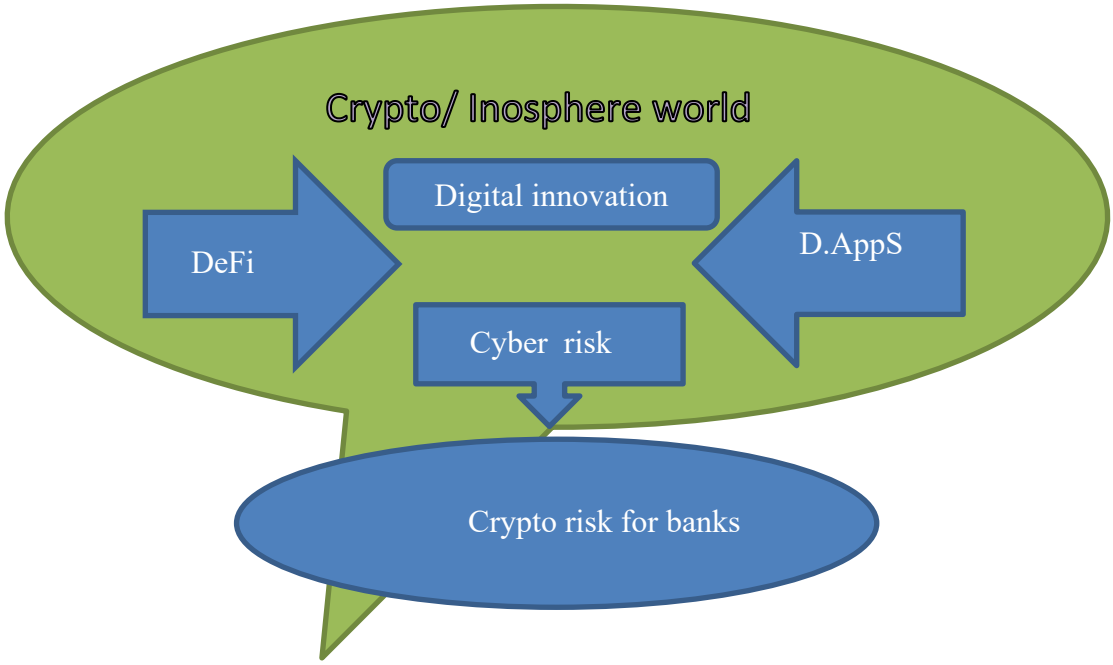

Figura 1. Layer of Metaverse

Source: Preparated by the autor inspired by the work Luciano Floridi Metaverse: a Matter of Experience (2022)

In the field known as the industrial Metaverse, exemplified by the Nvidia Omniverse platform, companies are building digital twins to design and monitor physical objects. Businesses are also using virtual reality (VR) to train employees and applying augmented reality (AR) to overlay information on real-world objects, helping their employees work better.

The growing interest and investment in augmented reality prompted the Pew Research Center and Elon University's Imagining the Internet Center to ask hundreds of technology experts to share their opinions on the topic. In total, 624 technology innovators, developers, business and political leaders, researchers, and activists provided open-ended responses to a question asking for their predictions about the trajectory and impact of the metaverse through 2040 (The Metaverse in 2040, report 2022).

The results of this survey:

- 54% of these experts said they expect the metaverse to be a much more defined and truly immersive and functional aspect of everyday life for half a billion or more people globally by 2040.
- 46% said they expect that by 2040, the metaverse will not be a much more refined and truly fully immersive and well-functioning aspect of daily life for half a billion or more people globally.

The Republic of Moldova has already approved its Smart Specialization Strategy for the period up to 2030. The directions and tasks of this strategy are:

- Focusing resources on those sectors where Moldova has natural competitive advantages or innovation potential (AgriTech, ICT, Energy, Biomedicine);
- Connecting Research with Industry: Stimulating joint projects (technology transfer) between universities, research institutes, and private companies;
- Infrastructure development: Creating and modernizing research and innovation infrastructure in the targeted areas;
- Integration into global value chains: Capitalizing on opportunities to connect innovative products and services to international markets.

The Specific Priority Areas are:

1. Agriculture and Agricultural Product Processing (AgriTech): Modernizing agriculture through technology.
2. Information and Communication Technology (ICT): Digital transformation, software development, and IT services.
3. Sustainable Energy: Focus on renewable sources and energy efficiency.
4. Biomedicine and Biopharmaceuticals: Development of the pharmaceutical and medical sector.

These are necessary things, but at the same time, the primary focus is on agriculture. There is not much emphasis on cutting-edge technologies. In this way, we believe it would be necessary to propose and implement AI Strategies and Blockchain Strategies. However, in order to see what we can propose, what steps we can take to move on to another stage of development more quickly.

Given the scope and interest in these technologies, we sought to evaluate the Moldovan economy's innovative potential. To this end, we analyzed the basic components of the country's GDP, specifically the percentage of industries, compared to EU member states. As shown in Table 1, the financial banking sector has a low share compared to countries with moderate economic levels within the EU, while the agricultural sector has a significant share.

This suggests that there is potential to develop the financial banking industry, which could be interested in using blockchain technology for more than just cryptocurrency.

Table 1. Share of industries in GDP, 2024, three countries compared

Indicators	Republic of Moldova	Latvia	Romania
Banking fin. service% GDP	16,8	21,7	20,9
Agriculture % GDP	8,2	4,6	3,1
Construcțion % GDP	8,3	6	8,8
Industry % GDP	12,2	15,2	19,1
Transport, communication, hotel service %GDP	34,1	28,6	30,3

Source: Prepared by the author based on UNECE report 2025

In order to deepen the analysis, we compared the level of innovation in our economy with that of the same EU countries, the intensity of the impact of knowledge, the collaboration between universities and local and European businesses, as well as the situation in cluster development. The situation shows a fairly significant gap between Moldova and countries such as Romania and Latvia. The relevant data can be seen in Table 2.

Table 2. Level of business sofistication

Indicators	Latvia	Romania	Republic of Moldova
Knowledge intensive %	47,7	35,5	19
GERD finance by business %	37,3	56,2	15,5
University industry. R&D collaboration%	40,1	31,4	8,6
Univ.industry international angagement%	26,1	16,6	0
State of cluster development	32,4	37,4	19,3
Research talent % in business	31,7	34,4	6,2

Source: Prepared by the author based on the GII Report 2025, WIPO

Although we are behind EU countries, we are taking steps to boost industrial innovation and establish connections between the research community and businesses.

As disruptive technologies continue to develop and emerge, this connection will become even more important and absolutely essential. First and foremost, we must develop new skills among specialists.

Digital skills are crucial for Europe's future. The Commission is investing in Europe's citizens to ensure they have the digital skills to access, use, and develop the latest technologies. This includes blockchain technology, for which there are initiatives focused on developing the technical, commercial, legal, and organizational skills necessary for its prosperity in the region. We have discussed the need to prepare for the new technologies associated with Industry 5.0 in other papers, focusing on the revision of study programs and skills that also include aspects of blockchain (Pisaniuc, 2023).

Due to the complexity of the blockchain ecosystem, a wide range of blockchain occupations exist, each requiring different sets of skills. Figure 2 outlines how previously identified skills (with technological skills thresholds) might match different BC roles. For instance, BC Role 1 might refer to a BC Developer, who would need a strong basis of technological skills (expert level) and some transversal skills. While BC Role 3 might refer

to a position of a BC Manager, who would need a strong foundation in business and transversal skills and only some technological skills (general level). Therefore, designing a blockchain curriculum that fits all is not feasible. It is difficult to imagine a candidate who has strong business, cross-functional, and IT skills and an excellent understanding of industry specifics. Such individuals may exist, but they are rare. Companies should be aware of this and adjust their expectations accordingly. Building a blockchain curriculum is more of a journey than a one-time event, and blockchain training and education should be approached from a lifelong learning perspective.

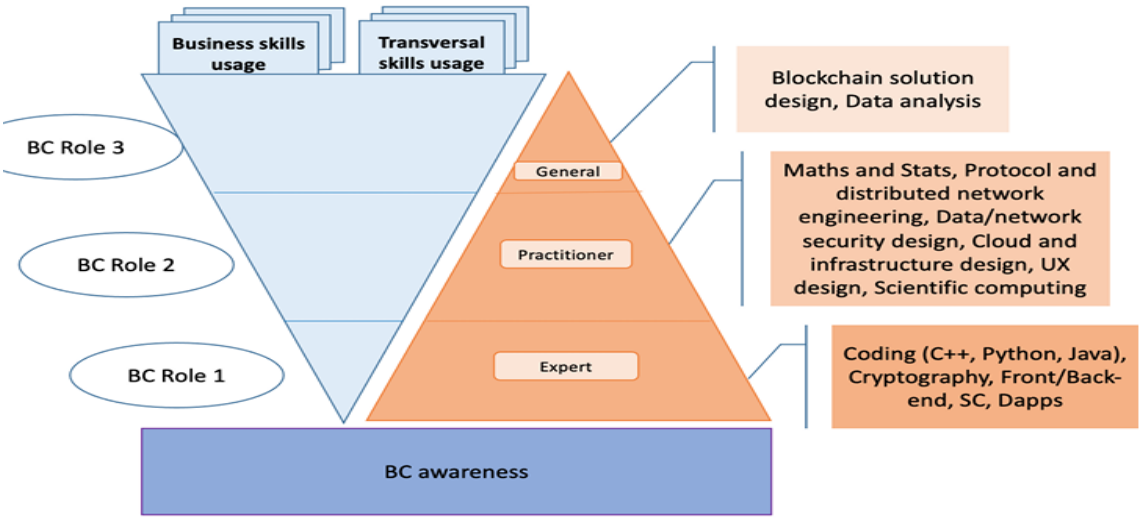

Figure 2. Cross-cutting and business skills of blockchain technology

Source: Taken from European document CHAISE_WP4_D4.3.1 Document title: D4.3.1 – European Blockchain Skills Strategy

The main mission of CHAISE, as a Sector Skills Alliance, is to address the skills gap in blockchain and develop a strategic approach to blockchain skills development in Europe.
The lack of a comprehensive strategic vision and holistic governance hinders the potentially broad, catalytic effects of government support. Innovation policy needs an intergovernmental coordination mechanism, such as a National Innovation Council, to guide and align innovation policy efforts. The potential for innovation at the subnational level, although partially addressed by regional smart specialization initiatives, remains largely untapped. Increasing the capacity of local authorities to systematically experiment with, facilitate, and promote innovation, including by scaling up existing successful initiatives, will be essential. These efforts should build on recent decentralization reforms, clustering efforts, and donor-supported pilot projects (e.g., StartUp City Cahul, Tekwill), and include subnational authorities in national-level governance through the National Innovation Council.

In order to assess the future potential of economic innovation, we analyzed the number of researchers, and our situation is better than Romania's if we compare it to the population size. However, we would like to mention the advanced average age of researchers. Another problem associated with this indicator is that some researchers in these

two countries are employed in business, so the proportion of talent in business is higher in Latvia (around 31.7%), Romania (34.2%), and the Republic of Moldova (6.2%).

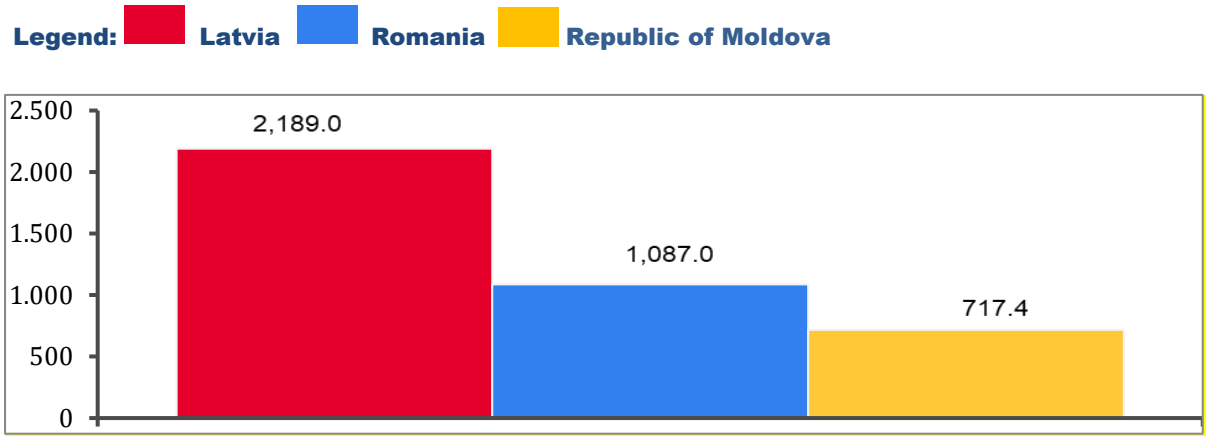

Figure 3. Number of full-time researchers in 2024

Source: Prepared by the author based on GII 2025, WIPO

In order to further the study, we analyzed education funding to assess the country's current actions. The results show that we have made the most progress, confirming the awareness of the need for quality education, because education is the essential pillar of innovation.

Table 3. Level of funding, share of education in the economy, 2024

Indicators	Latvia	Romania	Republic of Moldova
Education expenditure % GDP	5,4	3,3	6,6
Government funding per student, %	21,9	18,5	22,9
Tertiary education,%	38,6	36,1	33,6
Graduates in engineering and science,%	19,7	28,4	23,4

Source: Prepared by the author based on the GII Report, WIPO, 2025

Despite the positive quantitative indicators, we refer to the volume of funding and engineering specialists, we observe a substantial decline in the level of skills among our students, who are in fact the main indicators when analyzing future innovative potential.

Table 4. PISA index value and ranking position, by country, 2024

Indicator	Republic of Moldova	Latvia	Romania	Estonia	Switzerland
PISA (score)/ global ranking 1	414,0/53	483.9/22	427,9/47	515,6/6	497,9/9

Source: Prepared by the author based on the GII Report, WIPO, 2025.

PISA describes student achievement through proficiency levels, where higher levels indicate the ability to perform more complex tasks. Compare the relative positions of countries and should be interpreted with caution, as a change in ranking can be affected by the number of participating countries rather than solely by changes in student performance. In subjects like math and reading, a multi-stage adaptive design is used. Students are

directed to more difficult questions if they perform well on early ones, allowing for more accurate measurement across the full range of ability. To use blockchain technology, it would be beneficial to focus on STEM disciplines (stands for Science, Technology, Engineering, and Mathematics).

But you can't have low indicators compared to other countries and steer young people towards STEM. The results recorded for this indicator are modest both in our country and in Romania. We have also analyzed other countries that are currently leading in innovation. Not only are they currently leading countries in innovation, but they also have a more promising future potential. In order to apply blockchain, it is necessary to develop usage skills at various levels. New technologies and digital innovations are gradually reshaping many sectors. We can see how blockchain technology, in particular, has proliferated across different industries and functional roles in recent years, having a significant impact on the current labor market.

Conclusions

In line with European values and regulations, the EU blockchain/Web3 strategy supports the use and development of these areas. It provides improved trust services and ensures environmental sustainability, including data protection, digital identity, cybersecurity, and interoperability. It also promotes the transformation of cross-border industries and public services in Europe. Blockchain technology plays a pivotal role in establishing a citizen-centric digital society by facilitating electronic voting and proposing novel decentralized identity models. Blockchain technology is also key to sustainability.

Implementing Web 3 will lead to transitioning to the metaverse, where physical and virtual spaces converge. This space is accessed through computers and facilitated by immersive technologies, such as virtual reality, augmented reality, and mixed reality.

Due to the complexity of the blockchain ecosystem, a wide range of blockchain occupations exist, each requiring different blockchain skill sets. In this regard, each EU member state must focus on developing these skills. The Republic of Moldova's Smart Specialization Strategy until 2030 does not directly address the field in question. Some areas of innovation are specified without greater clarity in this context.

To this end, we conducted a comparative analysis between the current level of innovation in the country and that of other EU member states. The study shows that the Moldovan economy has a level of only 15.5% funding for business research and development, which is below the European average, and only 6.2% of research talent employed in business, compared to 34.4% in Romania. We also observed a moderate level of future innovation potential in the country, referring to its 53rd position in the PISA index, which is the lowest position among the countries compared. A necessary task is to align the country's innovation strategies and policies with those of the EU in order to achieve the EU average indicators, with a main focus on education and research. These two components define the country's innovative potential.

Blockchain technology is expected to grow significantly in the next few years. Considered innovative and revolutionary, this disruptive technology will change existing business processes by offering efficiency, reliability, and security. The European Blockchain and Web 3 Strategy outlines the necessary steps to build an innovative, inclusive, and sustainable Europe.

However, we would argue that research in this field is underestimated. Some consider it a fantasy technology, particularly in the context of the metaverse, while others view it as a technology used solely for producing and disseminating cryptocurrencies.

In the near future, blockchain technology will become a widely discussed field with a significant impact on the European economy. Analyses and impact studies can be conducted by applying econometric models. Currently, it is more complicated because there are no validated official data at the EU or global level, especially evolving data that reflect trends.

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